

Status of US Navy Ship Airwake CFD Efforts

Dr. C. W. S. Bruner

Ms. S. A. Polksky

Dr. W. Tseng

20000407 143

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

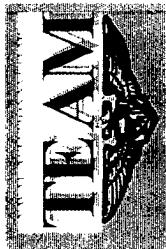
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

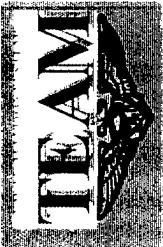
1. REPORT DATE	2. REPORT TYPE Viewgraphs	3. DATES COVERED		
4. TITLE AND SUBTITLE Status of U.S. Navy Ship Airwake CFD Efforts			5a. CONTRACT NUMBER	
			5b. GRANT NUMBER	
			5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Dr. C. W. S. Bruner, Ms. S. A. Polsky, Dr. W. Tseng			5d. PROJECT NUMBER	
			5e. TASK NUMBER	
			5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)			8. PERFORMING ORGANIZATION REPORT NUMBER	
Naval Air Warfare Center Aircraft Division 22347 Cedar Point Road, Unit #6 Patuxent River, Maryland 20670-1161				
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Naval Air Systems Command 47123 Buse Road Unit IPT Patuxent River, Maryland 20670-1547			10. SPONSOR/MONITOR'S ACRONYM(S)	
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.				
13. SUPPLEMENTARY NOTES				
14. ABSTRACT				
15. SUBJECT TERMS				
16. SECURITY CLASSIFICATION OF: a. REPORT Unclassified		17. LIMITATION OF ABSTRACT Unclassified	18. NUMBER OF PAGES 16	19a. NAME OF RESPONSIBLE PERSON Christopher Bruner
b. ABSTRACT Unclassified				c. THIS PAGE Unclassified

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18

Outline

- Brief Review of Physics
- The Ideal CFD Code Validation Experiment
- Generic Frigate Results
- LHA Results





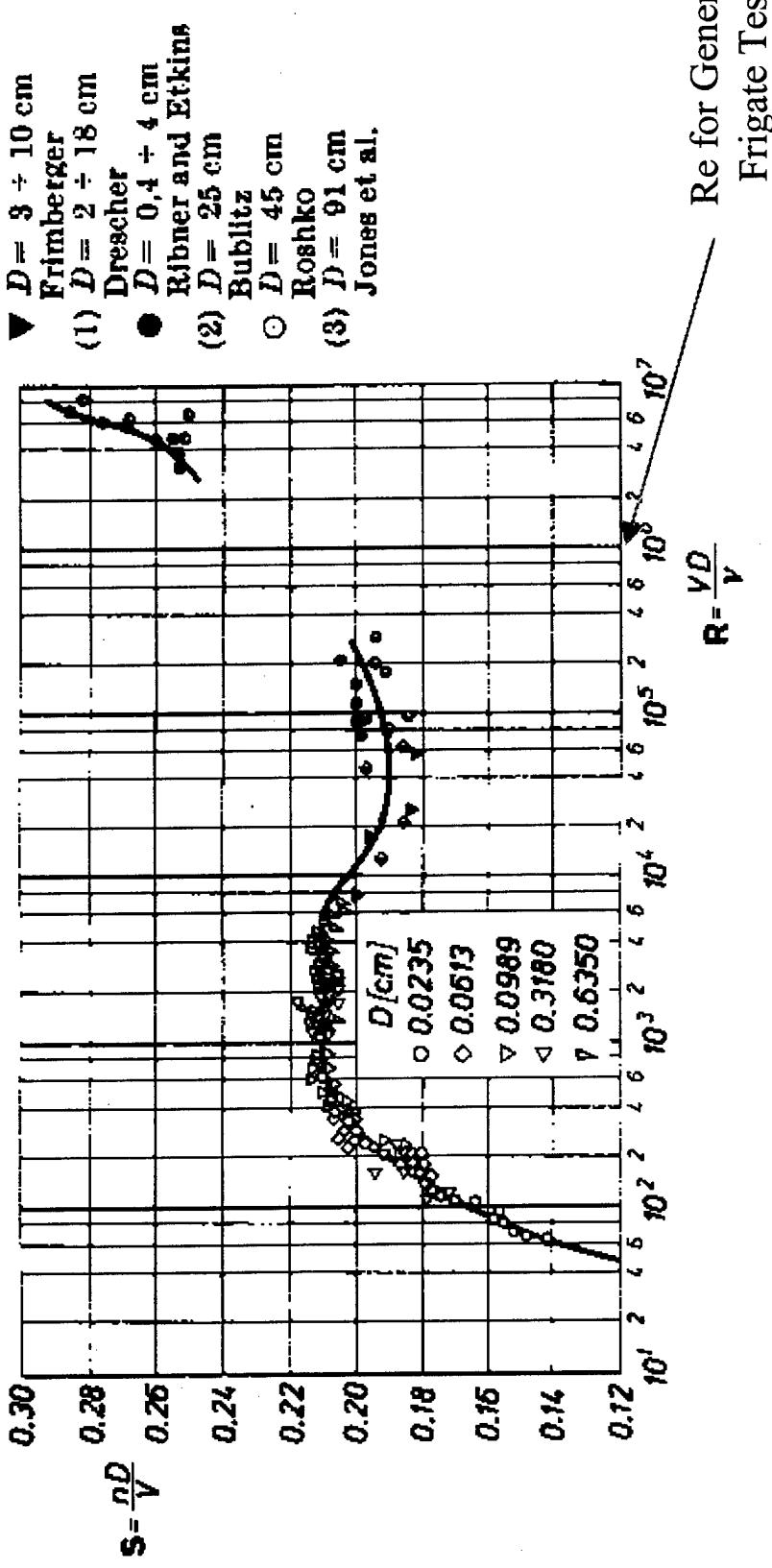
Simple Geometry, Complex Physics

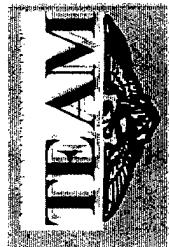


- Wake-dominated
- Strong Vortices
- Vortex Shedding
 - may be periodic, or not, depending on Reynolds number
- Data for full-scale Re is extremely hard to find (Bruce Johnson @ USNA?)



Schlichting Data for a Circular Cylinder



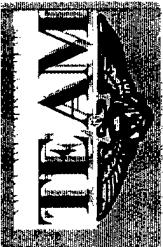


The Ideal CFD Code

Validation Experiment



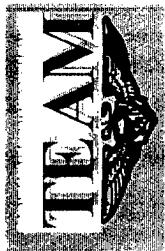
- Detailed Measurement of Boundary Conditions
 - inlet velocity profile
 - outlet pressure map
 - wall boundary layer measurements
- Redundant Data Measurements, e.g.,
 - LDV + pitot-static
 - taps + Kulites



Conclusions from Physics



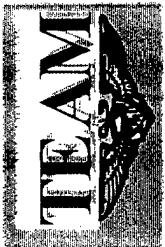
- Experiments Should
 - include unsteady measurements
 - include off-body measurements



Ideal Validation Experiment (cont.)



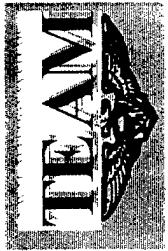
- Data Uncorrected for Wall, BL, Wake Effects
- Off-body Measurements



Pretty Good Validation Experiment



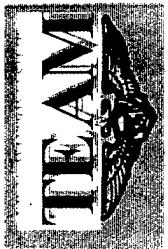
- NOT corrected for model or wake blockage
(we can run with walls)
- Corrected for Tunnel Wall BL (so those walls can be inviscid)
 - Some off-body data
 - Unsteady surface pressures



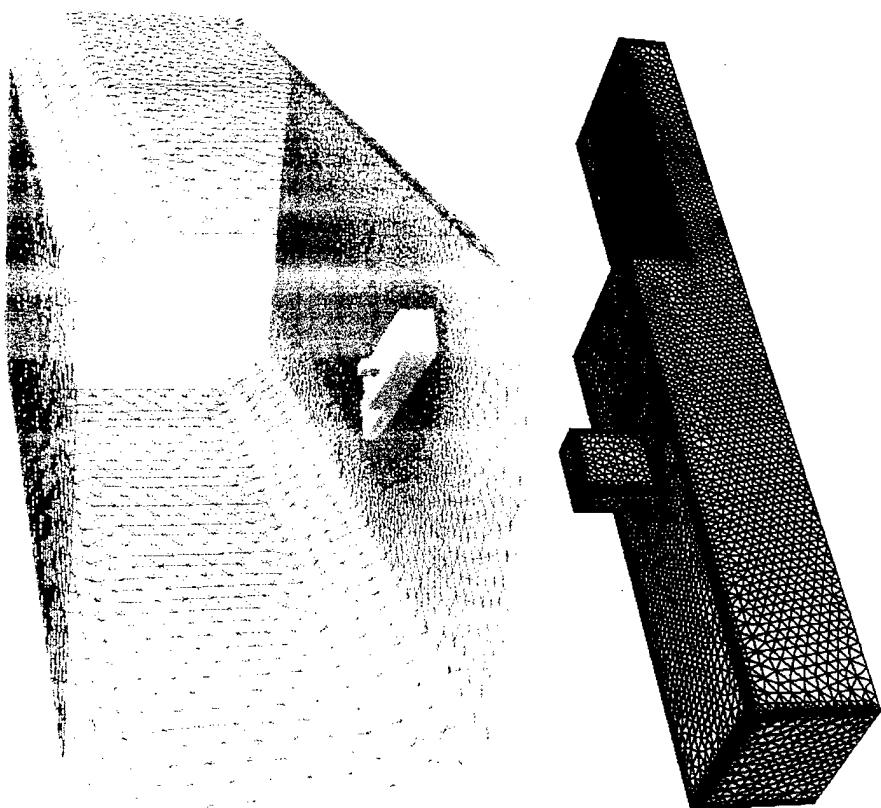
Generic Frigate Results

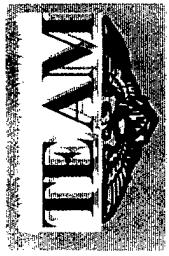


- Both structured and unstructured runs completed
 - in tunnel
 - free air
- Concentrated on 45° case, but have some 0° results as well

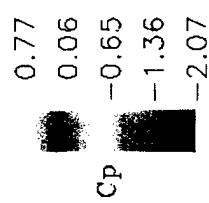


Generic Frigate Grids

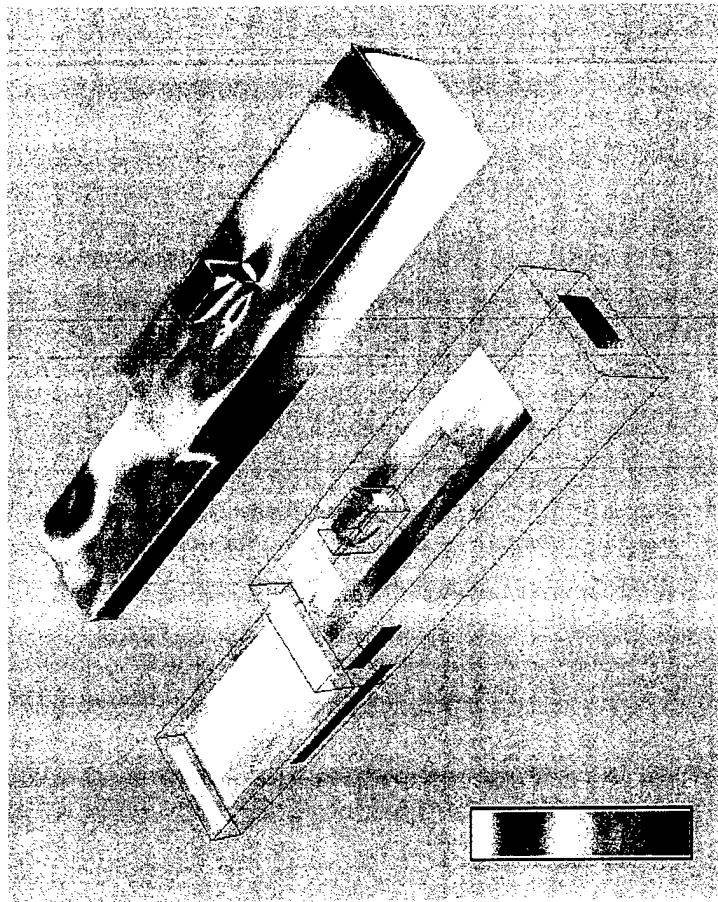




Generic Frigate Pressure Coefficient Contours



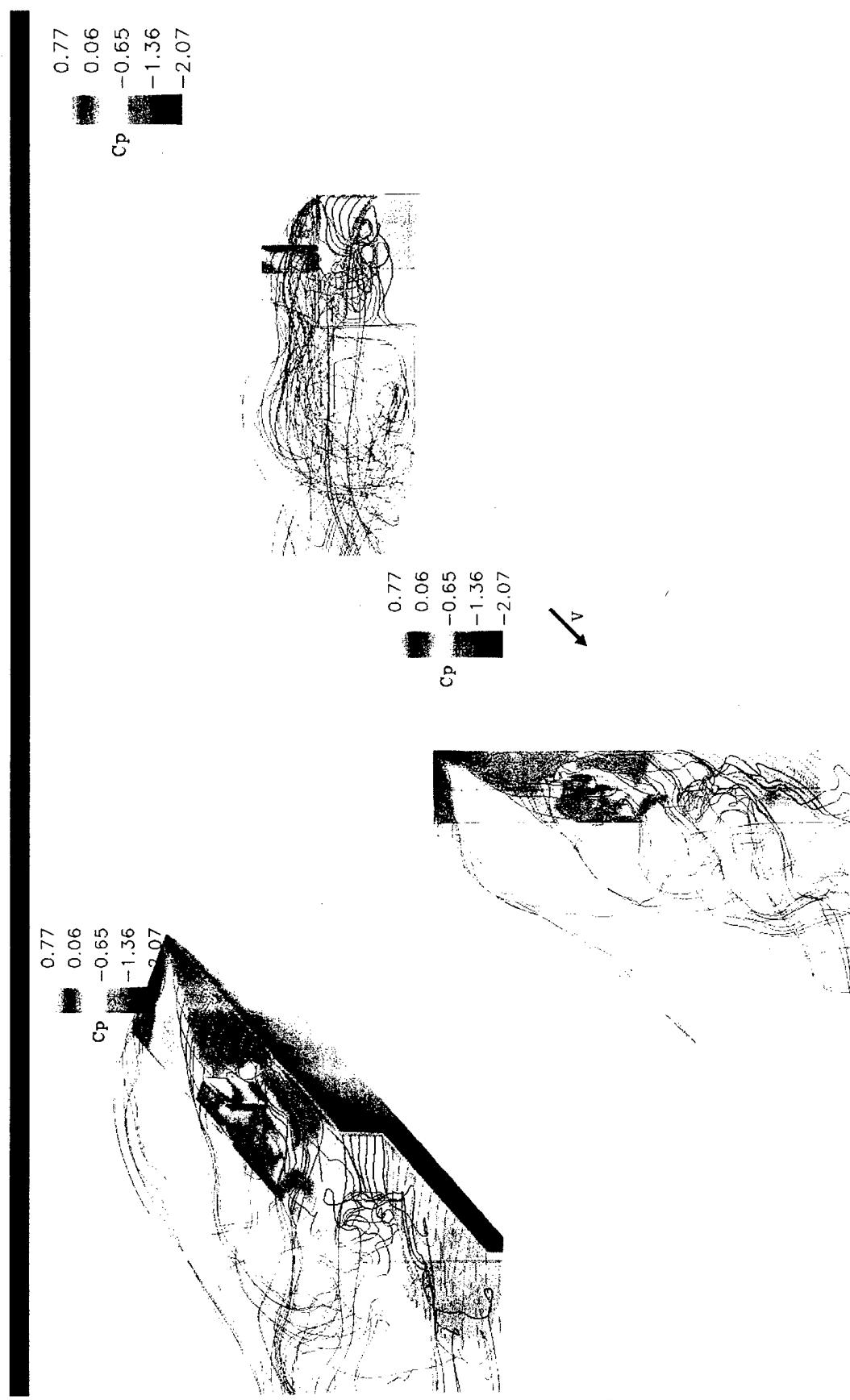
Unsteady laminar solution (snapshot)

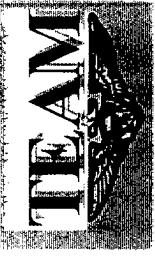


Steady laminar solution w/experimental data



Generic Frigate Streamlines



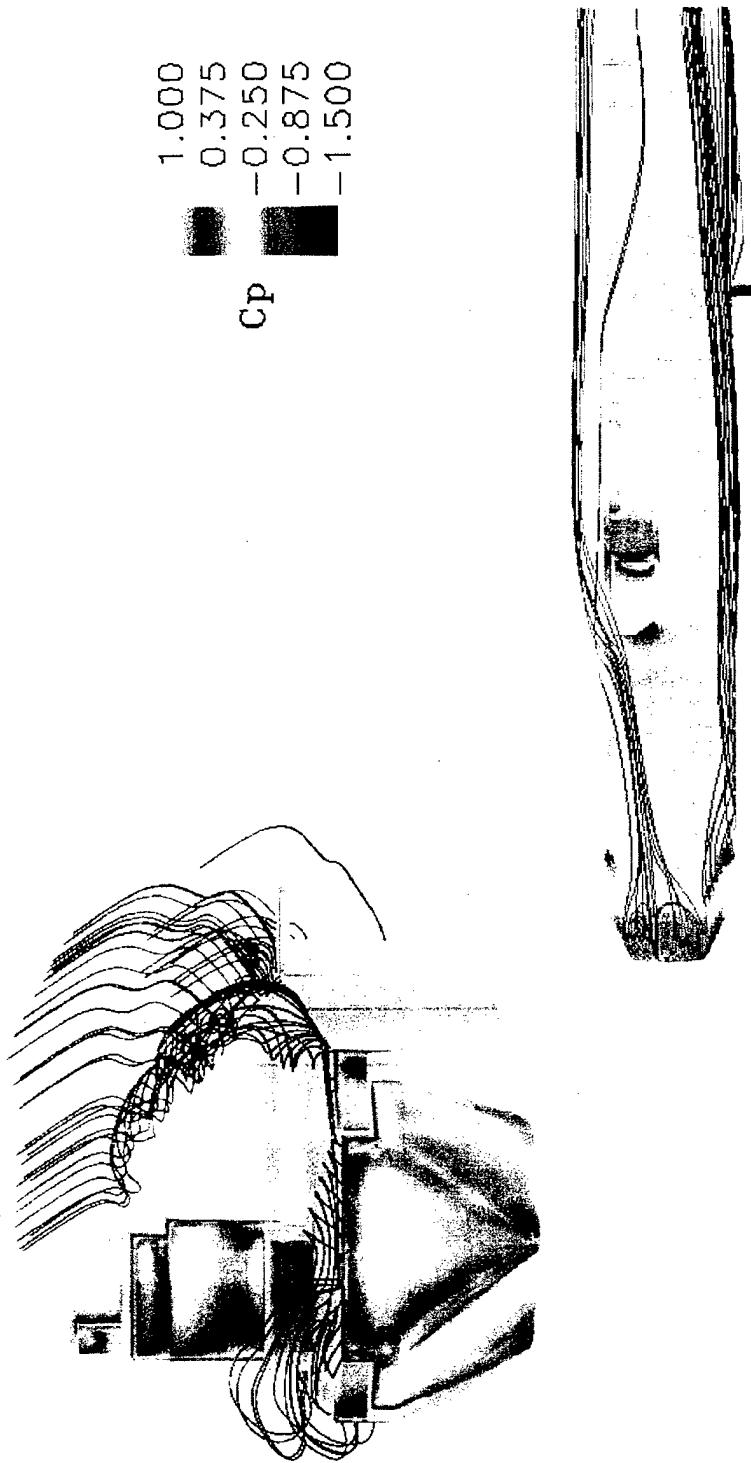
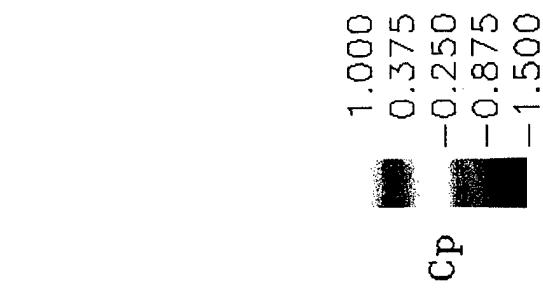
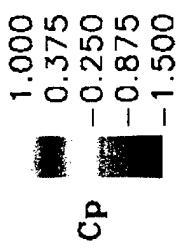
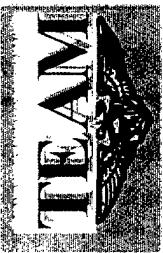


LHA Pressure

Coefficient Contours



LHA Streamlines





LHA Crossflow

Velocity Contours



Conclusions

- Unsteady computations are necessary to capture flow physics
 - flow is inherently unsteady
- Rotor modeling critical to computing hover flight conditions
 - crossflow velocities much smaller than rotor downwash, but a LOT of fluid is affected
- Full-Scale Reynolds number testing is needed

